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SAM-TDR-62-127

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# HEARING OF AIR FORCE PILOTS: 1955 TO 1962.

TECHNICAL DOCUMENTARY REPORT NO. SAM-TDR-62-127

December 1962

USAF School of Aerospace Medicine  
Aerospace Medical Division (AFSC)  
Brooks Air Force Base, Texas

Task No. 775503

ASTIA  
FEB 19 1963

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## **FOREWORD**

**This report was prepared in the Audiology Laboratory of the Ear, Nose, and Throat Department by—**

**LOIS L. ELLIOTT, Ph.D.**

**The author acknowledges the help of Airman First Class John D. Beuchler and Airman Second Class John R. Oyarzo, who assisted with analysis of the data. Richard McNee of the Biometrics Department directed the computer procedures. This survey was made possible by the efforts of the staff audiologists from 1955 until the present time.**

#### ABSTRACT

This report surveys the hearing levels of all Air Force pilots examined at the School of Aerospace Medicine from 1955 through mid-April 1962. Pilots are found to have generally superior hearing when compared by age groups with hearing levels of two comparison groups.

This technical documentary report has been reviewed and is approved.



ROBERT B. PAYNE  
Colonel, USAF, MSC  
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## HEARING OF AIR FORCE PILOTS: 1955 TO 1962

### 1. INTRODUCTION

Several staff members of the Audiology Laboratory, on the basis of their clinical experience with patients examined at this facility, have believed that pilots, as a group, exhibit greater hearing losses than do individuals of comparable age in other samples. The tendency has been noted particularly for the higher sound frequencies. This report was prepared in order to check the accuracy of this clinical opinion as well as to provide current information concerning the hearing levels of Air Force pilots. The results of the audiologic examinations administered to pilots at the School of Aerospace Medicine during the last seven years are summarized and compared to the hearing levels of two other populations.

An underlying reason for interest in pilots' hearing is the question of whether aircrew members experience hearing loss as a result of the noise levels to which they are exposed. Some investigators believe that the potential hazard is not great (2, 9), while others have detected hearing losses among flying personnel which they attribute directly to noise exposure (5, 7, 8). In planning the present evaluation, it was believed that any dramatic results indicating poorer hearing for pilots than for other groups would supply background data for developing a controlled test of the influence of noise on pilots' hearing. This report, for reasons explained in following sections, does not constitute such a definitive test.

### 2. METHOD

Records were examined for all pilots tested in the Audiology Laboratory from 1955 through April 1962. Since all patients that are referred to Consultation Services of the School

of Aerospace Medicine for any reason are scheduled for audiologic testing, this sample may be considered as being fairly representative of the total pilot population insofar as hearing level is concerned. Subjects experiencing acute otologic pathology (as noted on the record card) at the time of testing were rejected from the sample. Only the most recent audiologic measurements were included for pilots who returned for more than one test session. No attempt was made to ascertain the number of flying hours or the type of aircraft flown. Previous experience has shown that the number of flying hours is highly correlated with age (3); if a two-way classification scheme were attempted for these variables, the number of cases in some cells would become unmanageably small. Air conduction scores for a total of 835 pilots were utilized.

The environmental conditions under which the audiometric tests were administered necessarily varied over the years as newer and better equipment was installed in the laboratory. However, testing was accomplished at all times by experienced audiologists who used standardized procedures and equipment. It is believed that error introduced by variation in test equipment and personnel is minimal.

### 3. RESULTS

Basic results are presented in table I which lists the 25th, 50th, and 75th percentiles for each ear on each of eight frequencies for six age groups and for the total sample. In the youngest age group (20 to 24 years) median hearing is superior to the standards of the American Standards Association (1) at all frequencies. No loss of hearing occurs except when the 75th percentile response to higher frequencies is examined. Across age groups,

**TABLE I**  
*Hearing levels of Air Force pilots (re American Standards Association)  
in percentiles for each frequency and each ear by age groups*

Frequency (cps)	Right ear				Left ear			
	N	25%	50%	75%	N	25%	50%	75%
<b>20 to 24 years</b>								
250	23	-10	-10	- 9.7	23	-10	-10	-10
500	31	-10	-10	- 6.0	31	-10	-10	- 6.4
1000	31	-10	- 9.0	- 5.7	31	-10	-10	- 6.1
2000	31	-10	- 8.2	- 4.0	31	-10	-10	- 4.6
3000	31	-10	- 6.1	+ 0.6	31	-10	- 5.5	+ 1.6
4000	31	- 8.3	- 3.2	+ 4.1	31	- 8.9	- 3.7	+ 4.1
6000	30	-10	- 5.0	+ 4.4	30	- 7.9	- 1.7	+ 7.5
8000	23	-10	-10	+16.3	23	-10	-10	+ 0.4
<b>25 to 29 years</b>								
250	118	-10	-10	- 9.4	118	-10	-10	-10
500	125	-10	-10	- 6.6	125	-10	-10	- 7.2
1000	125	-10	-10	- 6.1	125	-10	-10	- 6.1
2000	125	-10	- 9.4	- 3.5	125	-10	- 8.7	- 2.4
3000	125	- 8	- 3.7	+ 4.9	125	- 8.0	- 2.6	+ 7.3
4000	125	- 6.4	- 0.4	+10.4	125	- 4.4	+ 2.0	+17.0
6000	124	- 4.4	+ 3.5	+19.0	123	- 2.0	+ 5.2	+19.4
8000	118	-10	- 5.0	+ 8.9	118	-10	- 1.3	+12.2
<b>30 to 34 years</b>								
250	142	-10	-10	-10	141	-10	-10	- 9.2
500	158	-10	-10	- 5.4	157	-10	-10	- 6.6
1000	158	-10	- 9.0	- 3.6	158	-10	-10	- 5.6
2000	158	-10	- 8.7	- 1.8	158	-10	- 7.7	- 1.9
3000	158	- 6.7	- 0.7	+13.0	158	- 5.3	+ 2.1	+15.3
4000	158	- 2.1	+ 6.9	+30.4	158	+ .9	+11.3	+27.7
6000	158	- 2.2	+10.0	+35.4	158	- .5	+12.9	+29.2
8000	144	-10	+ 3.0	+22.1	144	- 9.7	+ 1.9	+18.5
<b>35 to 39 years</b>								
250	213	-10	-10	- 6.2	213	-10	-10	- 7.7
500	228	-10	- 9.2	- 3.0	228	-10	-10	- 5.0
1000	228	-10	- 6.8	+ 1.2	228	-10	- 7.8	- 1.1
2000	228	-10	- 5.9	+ 5.4	228	- 9.7	- 4.1	+ 9.1
3000	227	- 3.7	+ 4.2	+19.3	227	- 0.6	+ 9.6	+29.0
4000	227	+ 3.0	+12.5	+39.5	227	+ 4.9	+22.5	+47.0
6000	225	+ 2.0	+15.8	+44.9	225	+ 6.1	+23.0	+47.0
8000	211	- 5.8	+ 7.7	+32.9	211	- 0.9	+13.6	+35.1



TABLE I (continued)

Frequency (cps)	Right ear				Left ear			
	N	25%	50%	75%	N	25%	50%	75%
40 to 44 years								
250	232	-10	-10	- 8.9	232	-10	-10	-10
500	237	-10	- 9.9	- 5.7	237	-10	-10	- 5.8
1000	237	-10	- 7.9	- 4.6	237	-10	- 7.5	- 2.4
2000	237	- 9.7	- 5.8	+ 4.0	237	- 9.7	- 4.4	+ 8.8
3000	237	- 7.9	+ 5.5	+24.4	237	- 1.6	+11.7	+34.9
4000	237	+ 3.2	+15.2	+41.6	237	+ 6.5	+22.0	+44.9
6000	236	+ 2.4	+15.0	+42.3	236	+ 5.0	+20.7	+44.3
8000	232	- 6.9	+ 6.9	+33.8	232	- 1.8	+10.8	+33.2
45 to 69 years								
250	55	-10	-10	- 7.8	55	-10	-10	- 5.9
500	56	-10	- 7.7	- 1.1	56	-10	- 8.1	- 1.2
1000	56	- 9.8	- 6.2	+ 0.0	59	-10	- 6.9	+ 5.0
2000	56	- 8.6	- 2.8	+25.0	56	- 8.0	+ 1.0	+26.7
3000	56	- 1.7	+11.7	+36.7	56	+ 1.9	+22.0	+41.0
4000	56	+ 7.5	+24.0	+44.0	56	+10.0	+28.8	+52.5
6000	56	+ 9.0	+27.5	+50.0	56	+11.2	+30.8	+55.0
8000	54	+ 0.8	+14.3	+38.8	54	+ 3.1	+21.7	+43.1
20 to 69 years								
250	783	-10	-10	- 8.3	782	-10	-10	- 9.2
500	835	-10	-10	- 5.1	834	-10	-10	- 5.8
1000	835	-10	- 8.1	- 2.9	835	-10	- 8.6	- 3.1
2000	835	-10	- 6.7	+ 1.7	835	-10	- 6.0	+ 4.7
3000	834	- 5.3	+ 1.9	+17.6	834	- 3.8	+ 5.1	+25.5
4000	834	- 0.3	+ 9.7	+34.8	834	+ 1.4	+15.3	+40.1
6000	829	- 0.3	+11.7	+39.2	828	+ 2.3	+15.3	+40.1
8000	782	- 8.9	+ 4.3	+29.0	782	- 6.0	+ 7.8	+28.9

the trend changes gradually until the median responses in the oldest group (45 to 69 years) show hearing losses in both ears at frequencies of 3000 cps and higher.

Table I indicates a general decrease in hearing acuity across age groups. Such decrease in hearing acuity with increasing age, however, is an accepted phenomenon termed "presbycusis." The important question is whether pilots experience a greater decrease in hearing

acuity than is observed in other groups. To examine this question it is necessary to compare pilots' hearing with data obtained from another sample. One survey which has been used for this type of comparison is the Wisconsin State Fair study of 1954 (4), which has the advantage of subdividing the total population tested into more homogeneous groups according to occupation, medical history, and other personal data. It is frequently assumed that the group of office workers reported in the

**TABLE II**  
*Differences in percentiles between men working in offices  
(1954 Wisconsin State Fair data) and Air Force pilots*

Age and number	Percentile	Frequency (cps)											
		500		1000		2000		3000		4000		6000	
		RE	LE	RE	LE	RE	LE	RE	LE	RE	LE	RE	LE
20 to 29 yr. N = 156 n = 69	25th	5.0	6.6	8.6	8.3	7.2	7.6	9.6	11.6	11.4	10.1	14.8	15.7
	50th	8.8	9.8	12.2	12.6	11.5	12.6	9.6	10.2	11.9	11.4	14.3	15.1
	75th	10.8	12.2	12.9	12.7	11.6	13.8	10.6	19.7	20.3	18.7	11.7	22.9
30 to 39 yr. N = 386 n = 87	25th	6.8	7.1	9.8	10.2	10.1	10.8	8.8	9.7	7.7	6.9	13.5	11.9
	50th	11.4	11.4	12.2	13.4	12.9	12.6	8.2	8.1	3.3	5.4	9.1	8.2
	75th	11.5	14.9	11.4	11.1	11.7	11.5	6.1	11.5	-3.5	1.8	2.0	4.0
40 to 49 yr. N = 278 n = 66	25th	8.0	8.5	13.2	11.2	11.5	11.3	12.2	9.2	8.2	5.6	16.3	17.1
	50th	13.5	13.4	14.5	13.9	14.2	13.3	11.5	8.3	6.2	0.2	17.3	9.9
	75th	15.9	14.6	17.8	14.6	14.6	6.5	6.6	-4.2	9.8	-9.0	13.8	2.4

N = Pilot data.

n = Wisconsin data.

Positive percentile difference indicates superior hearing of Air Force pilots.

**TABLE III**  
*Differences in percentiles of non-job-noise exposed Air Force personnel  
and Air Force pilot data*

Age and number	Percentile	Frequency (cps)											
		500		1000		2000		3000		4000		6000	
		RE	LE	RE	LE	RE	LE	RE	LE	RE	LE	RE	LE
18 to 24 yr. N = 31 n = 198	25th	4.7	3.5	3.7	3.3	3.9	2.9	8.0	8.5	6.7	8.0	4.8	2.8
	50th	8.2	8.0	7.1	7.9	7.2	10.4	10.8	10.9	8.6	10.0	6.3	4.4
	75th	8.2	9.2	7.3	8.3	8.7	11.8	11.4	10.4	8.6	12.3	4.3	3.9
25 to 29 yr. N = 125 n = 108	25th	4.4	4.6	3.9	3.2	2.0	4.8	8.3	5.0	6.6	8.3	0.3	2.4
	50th	8.0	8.7	8.2	8.6	9.0	9.3	10.7	11.2	9.6	9.4	1.4	0.8
	75th	9.0	9.9	8.4	10.1	8.1	9.5	9.8	9.5	9.5	5.7	-1.9	0.9
30 to 39 yr. N = 386 n = 99	25th	5.3	6.0	5.5	5.1	5.8	5.6	7.4	8.3	4.9	4.4	-2.2	0.3
	50th	9.4	9.9	7.6	8.5	7.7	10.2	5.4	5.0	4.5	0.6	-3.9	-3.5
	75th	7.9	8.8	5.3	7.0	4.6	3.8	1.1	-1.1	-3.4	-6.8	-14.9	-5.2
40 to 49 yr. N = 278 n = 36	25th	6.6	5.6	5.1	7.6	3.1	6.2	4.2	5.3	8.5	3.5	1.9	4.0
	50th	10.8	10.0	8.5	9.3	8.6	9.5	5.8	4.7	7.8	4.2	7.3	2.6
	75th	10.6	9.4	10.0	8.4	6.3	4.6	0.1	-0.1	-8.3	4.7	9.7	0.9

N = Pilot data.

n = Kopra and Strickland data.

Positive percentile difference indicates superior hearing of Air Force pilots.

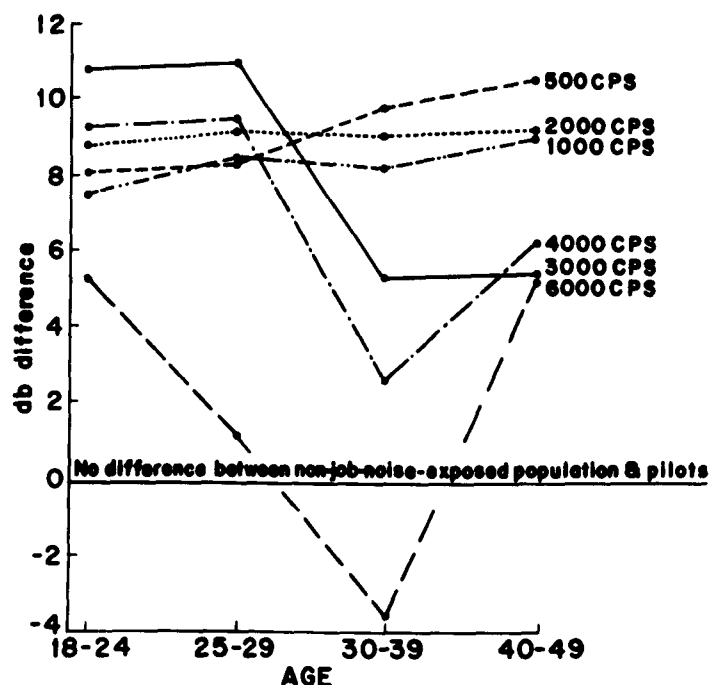


FIGURE 1

*Difference in hearing levels between non-job-noise-exposed Air Force personnel and Air Force pilots at the 50th percentile averaged for right and left ears.*

study represent a non-noise-exposed population. Although the assumption may not be fully justifiable, this group appears to be more desirable for comparison than some other large-scale studies in which all individuals tested were grouped regardless of past history. Table II presents differences in hearing levels between male office workers (Wisconsin data) and Air Force pilots. Positive entries in the table represent greater hearing loss for the population of office workers. With only three exceptions (and these occur for 75th percentile entries), pilots have better hearing than office workers of comparable age ranges.

It was desirable to compare data of pilots' hearing with that of a sample that was required to meet certain standards of health and hearing acuity. A study of this type was completed by Kopra and Strickland (6), who measured the hearing levels of a sample of non-job-noise-exposed Air Force personnel.

They examined the hearing of personnel whose jobs did not involve exposure to broad spectrum noise exceeding 95 db. Necessarily, the hearing of members of this non-job-noise-exposed sample met minimum Air Force standards. In all age groups pilots have better hearing at frequencies of 500, 1000, and 2000 cps. For 3000 and 4000 cps in the two older age groups there are several entries where members of the non-job-noise-exposed population have better hearing at the 75th percentile. At 6000 cps, pilots tend to have slightly poorer hearing particularly for the 30- to 39-year age group. The overall impression, however, is that the hearing of the pilot population is superior to that of the Air Force non-job-noise-exposed population.

Information in table III is rearranged and plotted in figure 1 which displays differences in decibels (between non-job-noise-exposed Air Force personnel and Air Force pilots) at the

50th percentile averaged for right and left ears and plotted across age groups. The figure indicates that the superior hearing of pilots, as compared to the other sample, is maintained across age groups for the speech frequencies. Higher frequencies, however, show considerable narrowing of differences between groups in the older age ranges.

The upward slopes of the curves for 500, 1000, 4000, and 6000 cps between the two oldest age groups are influenced by the fact that different individuals are represented in each age group. The greater difference of the 40- to 49-year group (as compared to the 30- to 39-year group) could be attributed to one or a combination of causes: (1) Men in Kopra and Strickland's 40- to 49-year group (with which pilots are compared) may have had particularly poor hearing; (2) pilots in the 40- to 49-year group may originally have had better hearing than those in the younger groups; (3) pilots in the 40- to 49-year group may have been currently assigned to administrative positions and, spending more time away from high-level noise, may have regained some hearing, particularly at the higher frequencies; or (4) retirement, either from the Air Force or from flying status, may have selectively removed older pilots with greater hearing losses. Data presently available in the Audiology Laboratory do not permit identification of the "true reason" for the changes in slope of the

difference curves. To adequately explain these results it would be necessary to specify a sample of pilots with known hearing levels and follow their audiometric performance over time. Ideally, a companion sample, matched for age and initial hearing levels, and not undergoing exposure to high-noise levels or other unusual environmental conditions, should be followed concomitantly. This procedure would supply solutions to the above-mentioned questions and answer the additional question of whether young individuals with particularly good hearing tend to maintain their superiority in relation to the general population or whether they "regress toward the mean" (i.e., tend to have average hearing) as they grow older.

The results indicate that Air Force pilots have relatively good hearing as compared to other groups. This does not confirm the clinicians' expectations of finding poorer hearing among pilots. The discrepancy between analyzed data and opinion, based on extensive clinical experience, is difficult to explain. It is possible that clinical opinion is influenced strongly by extreme cases which are not represented in the 75th percentiles reported here. It is also possible that grouping of data into decade age groups has in some way obscured real differences which might be highlighted by some other treatment of the data, although this seems unlikely.

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<p>USAF School of Aerospace Medicine, Brooks AF Base, Tex.</p> <p>SAM-TDR-62-127. HEARING OF AIR FORCE PILOTS: 1955 TO 1962. Dec. 62, 6 pp. incl. illus., tables, 9 refs.</p> <p>Unclassified Report</p> <p>This report surveys the hearing levels of all Air Force pilots examined at the School of Aerospace Medicine from 1955 through mid-April 1962. Pilots are found to have generally superior hearing when compared by age groups with hearing levels of two comparison groups.</p>	<p>1. Audiology</p> <p>2. Hearing conservation</p> <p>I. AFSC Project 775503</p> <p>II. Elliott, L. L.</p> <p>III. In ASTIA collection</p>	<p>USAF School of Aerospace Medicine, Brooks AF Base, Tex.</p> <p>SAM-TDR-62-127. HEARING OF AIR FORCE PILOTS: 1955 TO 1962. Dec. 62, 6 pp. incl. illus., tables, 9 refs.</p> <p>Unclassified Report</p> <p>This report surveys the hearing levels of all Air Force pilots examined at the School of Aerospace Medicine from 1955 through mid-April 1962. Pilots are found to have generally superior hearing when compared by age groups with hearing levels of two comparison groups.</p>	<p>1. Audiology</p> <p>2. Hearing conservation</p> <p>I. AFSC Project 775503</p> <p>II. Elliott, L. L.</p> <p>III. In ASTIA collection</p>
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